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ORIGINAL ARTICLE

Syntax score calculation with Multislice Computed Tomographic Angiography in comparison to invasive coronary angiography

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KEYWORDS

Syntax score;
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Abstract The aim was to study the feasibility of syntax score calculation with Multislice Computed Tomographic Angiography (MSCTA).

Methods: Syntax score was calculated and compared for 91 consecutive patients underwent MSCTA and Invasive coronary angiography (ICA).

Results: MSCTA for the diagnosis of >50 % stenosis per coronary artery showed that MSCTA had a specificity, sensitivity, specificity, negative predictive value and accuracy of 92.2% (217/235), 97.1% (125/129), 98.2% (217/221), and 94.3% (364/386) respectively. Agreement between modalities was high with a kappa of 0.74. There was a positive correlation between MSCTA and ICA Syntax scores ($r = 0.73$, $p = 0.000$). The mean Syntax score was 15.8 ± 7.16 for ICA versus 16.3 ± 7.6 for MSCTA (Kappa of Cohen 0.66, $p = 0.000$). The Bland–Altman plot revealed that the estimated bias was 1.9 ± 3.4 and the most bias occurred with a higher syntax score. Lesions per patient were more identified with MSCTA than ICA (2.5 ± 1.4 vs. 1.9 ± 1.1, $p < 0.001$), with a good level of agreement (kappa = 0.65). Syntax score per lesion was similar with a high level of agreement (6.3 ± 5.8 vs. 6.0 ± 4.8, kappa = 0.74, $p < 0.001$). Calcified lesions were identified to a similar extent (28 vs. 26 cases) with a fair level of agreement (kappa = 0.42). Lesions identified with both techniques showed a higher level of agreement than the total score (6.5 ± 4.8 for MSCTA vs. 6.9 ± 6.3 for ICA, $p < 0.05$), kappa = 0.76.

Conclusion: MSCTA showed a good level of agreement with ICA in syntax score calculation.

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1. Introduction

Coronary artery disease (CAD) is the leading cause of morbidity and mortality all over the world.[1]

The assessment of the severity of coronary artery disease (CAD) is essential in the management and prognosis of patients with CAD. Moreover, evaluations of the severity of CAD and its feasibility have a crucial impact on patients' outcome.[2,3]

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Invasive coronary angiography (ICA) is the gold standard for the diagnosis of CAD due to its high spatial and temporal resolutions.[4]

The synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery Score (SYNTAX Score) was developed to characterize coronary arteries with respect to the number of lesions, location, complexity, and functional impact. A higher SYNTAX Score indicates complex disease affection, a bigger therapeutic challenge, and a potentially worse prognosis in patients undergoing revascularization.[5]

Over the past decades, CT angiography emerged as a promising modality for the diagnosis of CAD.[6,7]

With recent progress and technical development of computed tomography (CT) scanners, images could be acquired very rapidly and with very high spatial resolution which allows a more accurate assessment of the level of coronary stenosis.[8]

Nowadays, SYNTAX score is a key determinant in therapeutic decision-making processes. European guidelines recommend creation of a heart team which serves the purpose of a balanced multidisciplinary decision process.[9,10] Therefore, knowing the Syntax score before ICA may help in proper decision making and ensure the best intervention circumstances.

The aim was to study the feasibility of non invasive calculation of Syntax score with MSCTA and compared it with that obtained from ICA.

2. Patients and methods

This study was conducted in the cardiology department, Assiut University hospital between June 2012 and October 2013. Exclusion criteria included post CABG patients and those with bad image quality. The final analysis included 91 patients. The duration between the two examinations was 10 ± 5 days.

Approval for the study was obtained from local ethics committee. Written informed consent was obtained from all patients.

2.1. CT angiography

MSCTA was made with a 64-slice CT (Aquilion 64; Toshiba, Tamara, Japan). Scanning parameters for CT were maximum tube voltage/current 140 kV/500 mA, collimation 64 × 0.5 mm, slice thickness 0.5 mm, rotation time 400 ms, and reconstruction thickness 0.5 mm.

All patients were prepared to keep their heart rate at 65 beats/minute or lower before imaging by giving Beta blockers either orally or IV and those with a contraindication to Beta blockers were given Ivabradine or Calcium channel blockers like Verapamil.

A standard non-contrast coronary calcium imaging protocol was made just before CT coronary angiogram for all patients and the total coronary calcium score was calculated using Agatston score.

Then 80–100 ml of non ionic iodinated contrast agent (Scanlux 370 or Ultravist 370) was injected through peripheral intravenous line using a dual head injector at a rate of 5–6 ml/s followed by 50 ml of intravenous saline as chaser.

Serial axial scans were taken at the base of the heart. Cardiac scan starts automatically when attenuation reached 130 Hounsfield units within the descending aorta (bolus tracking method).

ECG gated reconstructions were performed in the diastole (75% of the R–R interval). Other phases of reconstruction were done if there were any motion artifacts. The datasets were then displayed & examined on the workstation, using axial images, multiplanar reconstruction (MPR), maximum intensity projection (MIP) and volume rendering technique.[11]

2.2. Invasive coronary angiography (ICA)

Conventional invasive coronary angiography was performed using standard techniques through femoral or radial approach (Integris 3000, Philips Medical Systems, Netherlands). Images were acquired in optimal projection angles, at 25 frames per second, and were digitally recorded on Xcelera workstation.

2.3. Syntax score assessment

In a blinded fashion, the SYNTAX score was calculated retrospectively from ICA and MSCTA by two experienced interventional cardiologists using the SYNTAX score calculator (available at http://www.syntaxscore.com). Calculation was made after basic training on the web site. After basic training, reviewing several actual cases was made together to ensure agreement in definitions. In the case of disagreement, the opinion of a third observer was obtained, and consensus made the final decision.

The total SYNTAX score was composed of the individual scores for each separate lesion with a diameter stenosis of $\geqslant$50% in a vessel of $\geqslant$1.5 mm in diameter.[12]

2.4. Statistical analysis

Continuous variables are expressed as mean and standard deviation, and categorical variables are presented as frequencies and percentages. Correlation was performed with the Pearson correlation coefficient. Student's t test was used to compare continuous variables and chi-square tests for categorical variables. $P < 0.05$ was considered significant. Agreement between modalities was evaluated by Cohen's kappa. The strength of agreement was calculated according to Landis and Koch guidelines; none (<0), slight (0–0.2), fair (0.21–0.4), moderate (0.41–0.6), good (0.61–0.8), and almost perfect (0.81–1). Moreover, Bland–Altman analysis was applied as an additional measure of agreement between the two techniques. Data were analyzed using SPSS statistical software version 17.0 (SPSS, Chicago, IL, USA).

3. Results

The mean age of the study group was 55.8 ± 7.8 years, 40 (43.9%) were diabetics and 46 (50.5%) were hypertensive Table 1.

3.1. Contrast and radiation

More contrast was used with MSCTA than ICA (82 ± 4.6 versus 63 ± 5.3 ml, $p < 0.05$).

Patients were exposed to increased radiation with MSCT than ICA (5.7 ± 2.1 versus 3.5 ± 1.4 mSv, $p < 0.05$).

Table 1 shows clinical characteristics of patients ($N = 91$).

	Number (%)
Age	55.8 ± 7.8 years
Male	76 (83.5%)
Smokers	52 (56.5%)
Body mass index	30.2 ± 9 kg/m^2
Hypertension	46 (50.5%)
Diabetes mellitus	40 (43.9%)
Dyslipidemia	62 (68.2%)

3.2. MSCTA accuracy

MSCTA for the diagnosis of >50% stenosis (left main, left anterior descending, left circumflex and right coronary arteries), had a 92.2% (217/235) specificity, 97.1% (125/129) sensitivity, 98.2% (217/221) negative predictive value and 94.3% (364/386) accuracy. Agreement between the two modalities was high with a kappa of 0.74.

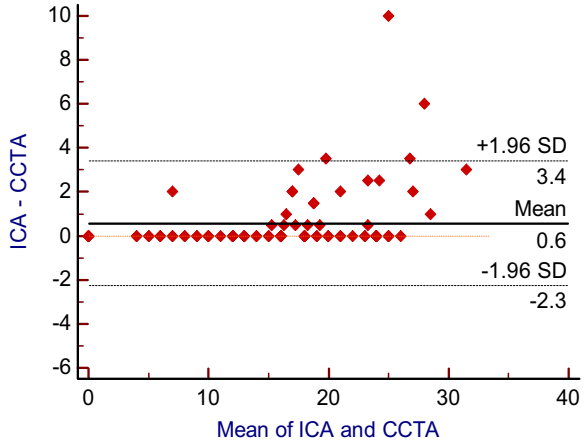

Figure 1 A Bland–Altman plot comparing patient-based SYNTAX scores based on the two techniques.

3.3. Syntax score

There was a positive correlation between MSCTA and ICA Syntax scores ($r = 0.73$, $p = 0.000$).

The mean Syntax score was 16.3 ± 7.6 for MSCTA versus 15.8 ± 7.16 for ICA, (Kappa of Cohen 0.66, $p = 0.000$). The Agatston score was 612 ± 627 units.

The Bland–Altman plot revealed that the estimated bias was 1.9 ± 3.4 and the most bias occurred with a higher syntax score Fig. 1.

Lesions per patient were more identified with MSCTA than ICA (2.5 ± 1.4 vs. 1.9 ± 1.1, $p < 0.001$), with a good level of agreement (kappa = 0.65).

Syntax score per lesion was similar with a higher level of agreement (6.3 ± 5.8 vs. 6.0 ± 4.8, kappa = 0.74 $p < 0.001$).

Calcified lesions were identified to a similar extent (28 vs. 26 cases) with a fair level of agreement (kappa = 0.40) Fig. 2.

Both bifurcation lesions and total occlusions were identified to a similar degree with MSCTA and ICA, (kappa = 0.38 for bifurcation lesions and 0.64 for total occlusion) Table 2.

For lesions identified with both techniques the level of agreement was higher than the total score (6.5 ± 4.8 for ICA vs. 6.9 ± 6.3 for MSCTA, $p < 0.05$, kappa = 0.76).

4. Discussion

SYNTAX Score has been developed to determine the complexity of coronary artery disease and to identify patients at risk of major adverse events following coronary interventions. Non invasive calculation of Syntax score with MSCTA would have important implications in patients' management.[13]

In the present study we found a good accuracy with MSCTA in the diagnosis of significant (>50%) coronary stenosis. This came in concordance with previous studies that have shown that MSCTA is highly accurate in the diagnosis of coronary stenosis when compared with ICA with excellent negative predictive values.[14,15]

There was a highly positive correlation between SYNTAX score calculated with MSCTA than that calculated with ICA with a good level of agreement. Kernerl et al. have found a fair agreement between the two techniques. The difference may be

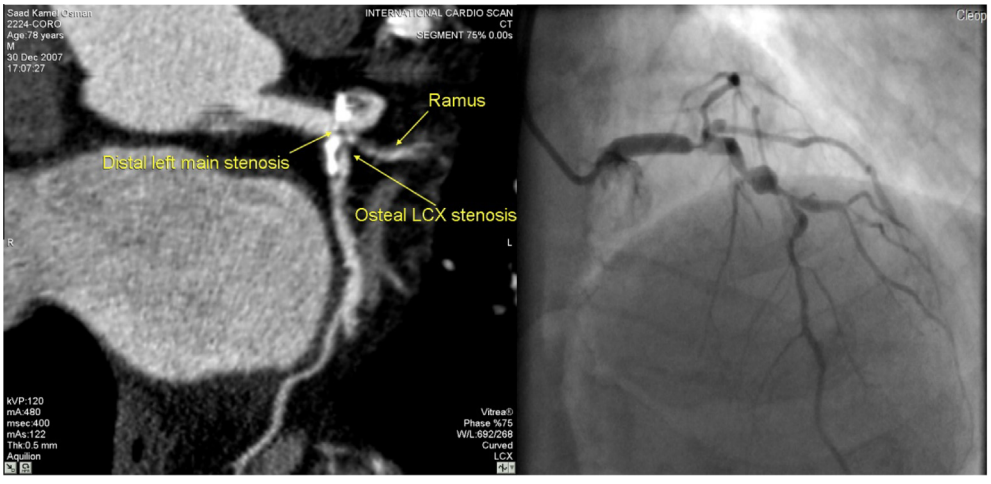

Figure 2 Complex left main lesion in MSCTA (left) and ICA (right).

Table 2 MSCTA versus ICA.

	MSCTA	ICA	Kappa
Syntax score total Mean ± SD	16.3 ± 7.6	15.8 ± 7.16	0.66
Lesions per patient	**2.4 ± 1.4**	**1.9 ± 1.1**	0.65
Syntax per lesion	6.3 ± 5.8	6.0 ± 4.8	0.74
Syntax score per lesions in the two techniques	6.9 ± 6.3	6.5 ± 4.8	0.76
Syntax for LAD	8.7 ± 6	8.4 ± 5.8	0.82
Syntax for LCX	4 ± 3	3.9 ± 3.5	0.75
Syntax for RCA	3.3 ± 3	3.2 ± 3.2	0.73
Bifurcation	52	54	0.38
Total occlusion	24	24	0.74
Calcified lesion	28	26	0.40

attributed to the exclusion of patients with bad image quality from the study. The current study included only patients with good image quality, which could also explain their interesting findings of more coronary lesion identification with ICA than MSCTA.[16]

The level of agreement for the Syntax score per lesion is higher than the level of agreement for the total score, especially for lesions identified with both techniques. Most of those lesions were present in proximal big sized arteries which made them to easily and accurately assess with MSCTA.

Estimated bias occurred with a high syntax score, this may be due to the association of a higher syntax with more complex lesions, with heavy calcification, bridging collaterals and small arteries.

Bifurcation lesions were recognized in a similar number, in both techniques; however, the level of agreement was fair. MSCTA has a better for the assessment of the ostium of the side branch; moreover, it can differentiate between plaque in the main branch and that in the side branch which may be difficult with ICA.[17]

In the current results the level of agreement between ICA and MSCTA is high in the diagnosis of the presence and the length of total occlusion. MSCTA is becoming the "go-to" imaging modality for chronic total occlusion intervention (CTO) planning. It offers the interventional cardiologist a clear view of the CTO. Specifically, it allows a distinct and accurate measurement of CTO length and visualizes proximal and distal segments near the occlusion. Moreover, MSCTA has the ability to define side branches within CTO vessels which despite the small caliber can be worthwhile to be treated.[18,19]

The Agatston calcium score of our patients was 612 ± 627 units. Coronary Calcification is one of the characteristics of atherosclerotic disease.[20] It is associated with future cardiac events.[21,22] Assessment of calcium score remains an advantage of MSCTA over ICA.

The level of agreement for calcified lesions was moderate. Most calcified coronary artery plaques undergo positive remodeling and do not lead to luminal narrowing.[23]

5. Limitations of the study

Retrospective nature and a relatively small number of study population are the main limitations of this study. Exclusion of patients with poor image might reflect selection bias in patient selection. On the other hand, we did not compare the two techniques regarding the incidence of contrast induced nephropathy (CIN).

6. Conclusion

This study showed a good level of agreement between 64 MSCT and ICA in syntax score calculation. Larger studies with new scanners of MSCTA are needed to confirm current results.

Conflict of interest

Nothing to declare.

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